Prevalence of Post-Coronavirus Illness Conditions and Associated Risk Factors among Adults in Saudi Arabia

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Abstract

Objectives: Various new, recurring, or ongoing health issues that appear at least four weeks after contracting COVID-19 are known as post-coronavirus illness (COVID) conditions. Early identification of people with post-COVID conditions and development of individual medical management plans can help them feel better and improve quality of life. Therefore, the objective if this study is to determine the prevalence of post-COVID conditions among adults in Saudi Arabia and investigate risk factors associated with post-COVID conditions.

Methodology: This study is a cross-sectional comparative design study. Using snowball sampling, a convenience sample of 307 Saudi adults participated in an online survey from April 2022 to August 2022 . A one-sample t-test was used to estimate the 95% confidence interval and population mean for perceived stress. The Chi-square test and odds ratio were used to assess the association and measure the effect size.

Results: Post-COVID conditions was highly prevalent among adults in Saudi Arabia (74.60%). Females, young adults, and those with higher stress levels were more likely to experience post-COVID conditions contrasted to male, and middle-aged adults respectively. Perceived stress was significantly associated with all post-COVID conditions, except fever (p = 0.32) and rash (p = 0.46).

Conclusions: To reduce symptoms and enhance quality of life, an individual medical management plan is required. Our results suggest that sex differences and stress levels should be considered in health promotion programs for post-COVID conditions. Attention should be paid to young adults to reduce post-COVID conditions and improve their health outcomes.

Keywords: Adults; Nurses; Percevied Stress; Post-COVID Conditions; Risk Factors; Saudi Arabia

Introduction

Various new, recurring, or ongoing health issues that appear at least four weeks after contracting COVID-19 are known as post-coronavirus illness (COVID) conditions [1,2]. The Center for Disease Control (CDC) states that post-COVID conditions can present in anyone who has tested positive for COVID-19, even in cases of mild illness or those lacking initial symptoms [2]. People may experience different combinations of the following symptoms: difficulty breathing, tiredness, post-exertion malaise, difficulty thinking and concentrating, cough, chest or stomach pain, headache, pounding heart, joint and muscle pain, pins-and-needles sensation, diarrhea, sleep disorders, fever, dizziness (lightheadedness), rash, mood changes, change in smell or taste, and changes in the menstrual cycle [1,2]. Most of these conditions improve

gradually over time. Nevertheless, in some cases after COVID-19 infection, post-COVID problems may persist for weeks, months, or even longer and lead to impairment [3]. Early identification of post-COVID conditions in indivduals and development of individual medical management plans can help affected people feel better and enhance their quality of life.

While the majority of COVID-19 patients have mild to moderate symptoms, approximately 10 to 15 percent of cases progress to serious conditions, and approximately 5% develop sever illness [1]. Generally, people recover from COVID-19 after two to six weeks. Although most people (80–90%) with COVID-19 return to normal health [1], some may experience symptoms that last for weeks or months after recovery from acute illness. Even people with mild illnesses who are not hospitalized may nevertheless have chronic symptoms, and some patients may encounter medical problems that have long-lasting repercussions on their health.

While older people and those with underlying medical issues might have a greater potential for severe COVID-19, young people, including those that were physically fit before COVID-19 infection, have also reported symptoms lasting several months after infection [3]. In the UK, preliminary findings from a nationwide representative sample poll indicate that approximately 1 in 10 people who tested positive for COVID-19 may experience symptoms for up to 12 weeks or longer [4]. Other research indicates that 27–80% of those who have had COVID-19 had not restored to their prior level of health when interviewed three to six weeks after recovery from the disease [5-8].

According to a recent Mayo Clinic study on post-COVID-19 conditions, more women than males had long-lasting effects. Men primarily had shortness of breath, while women exhibited signs of weariness, followed by muscle soreness and low blood pressure [9]. Additionally, Wang, et al. [10]. investigated psychological distress as an associated factor of post-COVID conditions in a prospective cohort study. Participants with two or more types of distress had an approximately 50% increased risk for post-COVID conditions [10]. However, the prevalence, risk factors, and causes of post-COVID conditions are not completely understood and are likely attributable to a variety of underlying mechanisms, including virus-specific pathophysiologic changes, immunologic aberrations, inflammatory damage, and anticipated physical and mental consequences of post-critical illness, like post-traumatic psychological stress [11].

Khodeir, et al. [12]. defined post-COVID conditions as symptoms occurring in people with a history of probable or confirmed severe acute respiratory syndrome coronavirus 2

that last for at least two months and cannot be explained by an alternative diagnosis. They also described the prevalence of post-COVID conditions and proposed a classification system to aid with identification and follow-up as a starting point. The most reported symptoms were general fatigue and weakness (73% each), loss of smell (64%), loss of taste (55%), diarrhea (53%), abdominal pain (50%), cough (47%), nausea (44%), mood changes (41%), dyspnea (43%), loss of appetite (42%), and insomnia (39%). However, the data from the previous study were not compared by sex or age, and risk factors were not investigated [12]. Therefore, further studies on post-COVID conditions are needed to understand their impact on health and the associated risk factors. Understanding post-COVID conditions would inform the approach to caring for people with post-COVID conditions.

This study aimed to determine the prevalence of post-COVID conditions among adults in Saudi Arabia and investigate risk factors associated with post-COVID conditions. We hypothesized that age, sex, prior health conditions, and perceived stress level would be associated with post-COVID conditions.

Methods

This was a cross-sectional descriptive study conducted in Saudi Arabia. Using snowball sampling, a convenience sample of 307 Saudi adults participated in this study from April 2022 to August 2022. The sample size was determined using G-Power software. Data were collected online using social networking. The inclusion criteria consisted of adults over 18 years of age, diagnosis of COVID-19 at least 30 days prior, and the ability to read and write in Arabic. Exclusion criteria included no history of COVID-19 infection or newly diagnosed with COVID-19 infection (within less than 30 days).

Ethical approval was obtained from Jazan University (Reference number: Reference number: REC-43/09/205). A brief introduction to the study was provided in the covering letter of the survey, and informed consent was obtained for completing the survey. Participation in the study was optional and anonymous.

This study was guided by King's Conceptual System. According to King Conceptual System, individuals are viewed as personal systems who are in constant interaction with environment to maintain, restore, or improve health [13]. Independent variables in this study included age, sex, vaccination status, prior health conditions, and perceived stress level. Dependent variable is post-COVID conditions. Age was measured on a categorical scale, where participants were asked to identify their age group: young adults (18

to 39 years), middle-aged adults (40 to 65 years), or older adults (65 years or older). Sex was classified as male or female. Vaccination status was defined as complete if they had received all recommended doses for COVID-19 and incomplete if they had not completed the recommended number of doses for COVID-19.

Prior health conditions included a diagnosis of one or more of chronic diseases before the onset of infection. Post-COVID conditions included difficulty breathing, dizziness upon standing, tiredness and/or fatigue, joint and/or muscle pain, chest and/or stomach pain, cough, post-exertion malaise, difficulty thinking and concentrating, headache, mood changes, changes in menstruation period, changes in smell and taste, pins and needles sensation, fast-beating or pounding heart, fever, and skin rash.

Perceived stress was measured using the Perceived Stress Scale (PSS), a ten-question scale that measures the personal perception of stress. It calculates the degree to which one's life is viewed as stressful [14]. In each question, the respondents were asked how often they felt a certain way. Higher score indicates higher perceived stress level. The reliability and validity of the PSS have been established in several studies. Cronbach's alpha for the Arabic version was found to be 0.74 [15]. Meanwhile, Cronbach's alpha for the current study was 0.86.

IBM SPSS statistics (V25.0) software was used to analyze the data. A descriptive analysis was used to describe the data and its main characteristics. A one-sample t-test was used to estimate the 95% confidence interval (CI) and population mean for perceived stress. The chi-squared test was performed to compare post-COVID conditions between men and women and between young adults (18 to 39 years) and middle-aged adults (40 to 65 years). The chi-squared value and odds ratio (OR) were used to assess the association and measure the effect size, respectively. The adjusted OR was calculated using binary logistic regression to adjust for covariates (sex, age, presence of prior health conditions, number of prior health conditions, number of past COVID infections, time of last COVID-19 diagnosis, and vaccination status). The chi-squared test and OR were also used to assess the association between post-COVID conditions and prior health conditions. The association between post-COVID conditions and perceived stress was assessed using the likelihood ratio, while the magnitude of the effect size was measured using the *Eta*-value.

Results

In total, 307 participants met the inclusion criteria. Table 1 presents the demographic data of the participants. For example, 53.1% were female and 54.4% were middle-aged adults. More than one-third of the participants had been diagnosed with a chronic disease before the onset of infection. Most of the participants had only been infected once (82.7%), and most infections occurred more than six months prior (46.9%). More than two thirds of the participants reported that the last COVID-19 infection occurred when their vaccination status was incomplete (67.4%). Finally, most participants reported having at least one post-COVID condition (74.6%).

Characteristics		Total number (n[%])	Has at least one post-COVID-19 symptom (n[%])	Does not have any post-COVID-19 symptom (n[%])	Complete vaccination status (n[%])	Incomplete vaccination status (n[%])
Total population		307 (100)	229 (74.6)	78 (25.4)	96 (31.3)	211 (68.7)
Age group	Young adult	140 (45.5)	95 (41.5)	45 (57.7)	43 (44.8)	97 (46.0)
	Middle-age	167 (54.4)	134 (58.5)	33 (42.3)	53 (55.2%)	114 (54.0)
Sex	Male	144 (46.9)	104 (45.4)	40 (51.3)	49 (51.0)	95 (45.0)
	Female	163 (53.1)	125 (54.6)	38 (48.7)	47 (49.0)	116 (55.0)
Employment status	Employed	217 (70.7)	165 (72.1)	52 (66.7)	77 (80.2)	140 (66.4)
	Unemployed	90 (29.3)	64 (27.9)	26 (33.3)	19 (19.8)	71 (33.6)
Prior health conditions	Absent	184 (59.9)	130 (56.8)	54 (69.2)	52 (54.2%)	132 (62.6)
	One present	69 (22.5)	48 (21.0)	21 (26.9)	20 (20.8%)	49 (23.2)
	>1 present	54 (17.6)	51 (22.2)	3 (3.9)	24 (25%)	30 (14.2)

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Vaccination status	Not vaccinated	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Incomplete	211 (68.7)	159 (69.4)	52 (66.7)		211 (68.7)
	Complete	96 (31.3)	70 (30.6)	26 (33.3)	96 (31.3)	
Duration between last COVID-19 infection and interview date	1.0 months	23 (7.5)	19 (8.3)	4 (5.1)	20 (20.8)	3 (1.4)
	1.1 to 2.9 months	61 (19.9)	43 (18.8)	16 (20.5)	29 (30.2)	30 (14.2)
	3.0 to 5.9 months	79 (25.7)	69 (30.1)	12 (15.4)	23 (24.0)	58 (27.5)
	6+ months	144 (46.9)	98 (42.8)	46 (59.0)	24 (25.0)	120 (56.9)
Number of COVID-19 infections	1	254 (82.7)	186 (81.2)	68 (87.2)	75 (78.1)	179 (84.8)
	2	44 (14.3)	35 (15.3)	9 (11.5)	17 (17.7)	27 (12.8)
	3	2 (.7)	2 (.9)	0 (0)	2 (2.1)	0 (0)
	4+	7 (2.3)	6 (2.6)	1 (1.3)	2 (2.1)	5 (2.4)

Table 1: Demographic characteristics of participants (n = 307).

In regards to prior health conditions, hypertension (37%), diabetes (36%), and depression or anxiety (34%) were the most commonly reported conditions. Tiredness and fatigue (29%), joint and muscle pain (24.8%), and mood changes (21.5%) were the most commonly reported post-COVID conditions (Table 2).

The mean score for perceived stress was 16.93 (SD = 8.17, range 0–40) with a 95% CI of 16.01–17.85 and a p-value <0.0001. The perceived stress was further analyzed based on sociodemographic factors. Younger adults (mean = 18.72, SD = 8.56), females (mean = 20.29, SD = 6.88), those who were unemployed (mean = 17.98, SD = 8.03), those who had prior health conditions (mean = 17.39, SD = 7.64), and those with three or more post-COVID conditions (mean = 21.57, SD = 7.62) had higher scores of perceived stress than their counterparts (Table 3).

Variables	Frequency	Percent
Prior Health Conditions:		
Hypertension	37	12.1
Diabetes	36	11.7
Depression or anxiety	34	11.1
Chronic pulmonary disease	19	6.2
High cholesterol level	17	5.5
Rheumatoid arthritis	13	4.2
Stomach ulcer	11	3.6
Anemia	8	2.6
Cancers	8	2.6
Thyroid disorder	8	2.6
Liver and/or kidney diseases	3	1
Post-COVID-19 Conditions:		
Tiredness and fatigue	89	29
Joint and/or muscle pain	76	24.8
Mood changes	66	21.5
Post-exertion malaise	64	20.8
Difficulty thinking and concentrating	61	19.9

Headache	52	16.9
Changes in menstruation period	44	14.3
Chest and/or stomach pain	40	13
Cough	39	12.7
Changes in smell and taste	37	12.1
Pins and needles sensations	36	11.7
Difficulty breathing	30	9.8
Dizziness upon standing	28	9.1
Fast-beating or pounding heart	23	7.5
Fever	14	4.6
Skin rash	11	3.6

Table 2: Prior health conditions and post-COVID conditions (n=307).

Variable	Actual Range					Possible Range	
	Minimum	Maximum	Mean	SD	95% CI	Minimum	Maximum
Perceived stress level	0	38	16.93	8.17	(16.01–17.85)	0	40
Age group						0	40
18–39	0	38	18.72	8.56	(17.46–20.01)		
40–65	0	36	15.43	7.54	(14.38–16.46)		
Sex						0	40
Male	0	34	13.12	7.85	(11.90–14.42)		
Female	1	38	20.29	6.88	(19.29–21.37)		
Employment Status							
Employed	0	38	16.49	8.21	(15.51–17.55)		
Unemployed	0	38	17.98	8.03	(16.49–19.52)		
Presence of Prior Health condition						0	40
Yes	0	38	17.39	7.64	(16.12–18.63)		
No	0	38	16.62	8.51	(15.50–17.83)		
Number of Post-COVID conditions						0	40
None	0	32	13.21	8.5	(11.42–15.04)		
One condition	0	31	15.39	6.55	(14.19–16.57)		
Two conditions	3	36	16	6.88	(13.73–18.44)		
≥ Three conditions	5	38	21.57	7.62	(20.07–23.08)		
*p<0.0001							

Table 3: Descriptive statistics for perceived stress (n=307).

Females were more likely to report post-COVID conditions, including fast-beating and pounding heart (91.30%), difficulty breathing (86.67%), dizziness upon standing (71.42%), tiredness and fatigue (65.16%), difficulty thinking and concentrating (63.93%), mood changes (63.64%), pins and needles sensation (61.11%), post-exertion malaise (59.38%), joint and muscle pain (57.89%), fever (57.14%), headache (55.77%), and cough (53.85%).

Table 4 compares post-COVID conditions by sex and age. Males were more likely to report a rash (72.73%) and changes in smell and taste (51.35%). Chest and stomach pain were equally reported between men and women (50.00%), and changes in menstruation were reported in 26.99% of the women. Difficulty breathing (p <0.001), tiredness and fatigue (p = 0.007), fast-beating or pounding heart (p < 0.001), and dizziness upon standing (p = 0.041) were significantly more common among women than men. After adjusting for age, the presence of prior health conditions, number of prior health conditions, number of past COVID infections, time of last COVID-19 diagnosis, vaccination status, the Adjusted OR for dizziness upon standing changed to insignificant (p = 0.170), while the adjusted OR for rash was significant (p = 0.043).

Adjusted OR for dizziness upon standing changed to insignificant (p = 0.170), while the adjusted OR for rash was significant (p = 0.043).	Sex/Age (years)	Symptomatic	OR (95% CI)	p-value	AOR (95% CI)	p-value
		229 (74.60%)				
Difficulty Breathing	Male	4 (13.33)	0.15 (0.05–0.44)	**<0.001**	0.17 (0.06–0.52)	**0.002**
	Female	26 (86.67)				
	18–39	20 (66.66)	0.38 (0.17–0.85)	**0.015**	0.38 (0.16–0.93)	**0.034**
	40–65	10 (33.34)				
Tiredness and Fatigue	Male	31 (34.84)	0.50 (0.300.83)	**0.007**	0.51 (0.29–0.91)	**0.023**
	Female	58 (65.16)				
	18–39	60 (67.42)	0.28 (0.17–0.47)	**<0.001**	0.29 (0.17–0.52)	**<0.001**
	40–65	29 (32.58)				
Post-Exertion Malaise	Male	26 (40.62)	0.73 (0.42–1.27)	0.258	0.84 (0.45–1.54)	0.563
	Female	38 (59.38)				
	18–39	41 (64.06)	0.39 (0.22–0.68)	**<0.001**	0.38 (0.20–0.72)	**0.003**
	40–65	23 (35.94)				
Difficulty thinking and concentrating	Male	22 (36.07)	0.57 (0.32–1.02)	0.058	0.66 (0.35–1.24)	0.197
	Female	39 (63.93)				
	18–39	37 (60.66)	0.47 (0.26–0.83)	**0.008**	0.46 (0.24–0.86)	**0.016**
	40–65	24 (39.34)				
Cough	Male	18 (46.15)	0.97 (0.49–1.89)	0.92	0.78 (0.36–1.69)	0.529
	Female	21 (53.85)				
	18–39	25 (64.10)	0.42 (0.21–0.85)	**0.013**	0.54 (0.24–1.19)	0.125
	40–65	14 (35.9)				
Chest or stomach pain	Male	20 (50)	1.15 (0.59–2.24)	0.67	1.66 (0.69–3.98)	0.255
	Female	20 (50)				
	18–39	29 (72.5)	0.27 (0.13–0.56)	**<0.001**	0.12 (0.04–0.32)	**<0.001**
	40–65	11 (27.5)				
Headache	Male	23 (44.23)	0.88 (0.48–1.60)	0.67	0.97 (0.48–1.94)	0.925
	Female	29 (55.77)				
	18–39	35 (67.31)	0.34 (0.18–0.64)	**<0.001**	0.31 (0.15–0.64)	**0.002**
	40–65	17 (32.69)				

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Fast-beating or pounding heart	Male	2 (8.7)	0.10 (0.02–0.41)	**<0.001**	0.11 (0.03–0.51)	**0.004**
	Female	21 (91.30)				
	18–39	14 (60.87)	0.51 (0.22–1.22)	0.126	0.64 (0.24–1.72)	0.379
	40–65	9 (39.13)				
Joint and Muscle Pain	Male	23 (42.11)	0.77 (0.46–1.30)	0.33	0.65 (0.36–1.16)	0.144
	Female	44 (57.89)				
	18–39	41 (53.95)	0.64 (0.38–1.08)	0.092	0.69 (0.38–1.26)	0.233
	40–65	35 (46.05)				
Pins and needles sensation	Male	14 (38.89)	0.69 (0.34–1.40)	0.3	0.79 (0.35–1.78)	0.573
	Female	22 (61.11)				
	18–39	19 (52.78)	0.72 (0.36–1.45)	0.36	0.59 (0.26–1.34)	0.205
	40–65	17 (47.22)				
Fever	Male	6 (42.86)	0.84 (0.29–2.49)	0.76	0.43 (0.08–1.44)	0.344
	Female	8 (57.14)				
	18–39	11 (78.57)	0.22 (0.06–0.79)	**0.011**	0.44 (0.10–2.06)	0.299
	40–65	3 (21.43)				
Dizziness upon standing	Male	8 (28.58)	0.42 (0.18–0.99)	**0.041**	0.52 (0.21–1.32)	0.17
	Female	20 (71.42)				
	18–39	19 (67.86)	0.36 (0.16–0.83)	**0.013**	0.24 (0.09–0.64)	**0.004**
	40–65	9 (32.14)				
Rash	Male	8 (72.73)	3.14 (0.82–12.06)	0.08	6.14 (1.06–35.57)	**0.043**
	Female	3 (27.27)				
	18–39	6 (54.55)	0.69 (0.21–2.31)	0.54	0.11 (0.01–0.83)	0.033
	40–65	5 (45.45)				
Mood Changes	Male	24 (36.36)	0.58 (0.33–1.01)	0.053	0.64 (0.35–1.18)	0.15
	Female	42 (63.64)				
	18–39	42 (63.64)	0.39 (0.22–0.69)	**<0.001**	0.40 (0.21–0.73)	**0.003**
	40–65	24 (36.36)				
Changes in smell and taste	Male	19 (51.35)	1.22 (0.62–2.43)	0.56	1.56 (0.71–3.43)	0.274
	Female	18 (48.65)				
	18–39	21 (65.76)	0.60 (0.30–1.20)	0.15	0.61 (0.27–1.38)	0.234
	40–65	16 (34.24)				
Changes in menstruation period	18–39	19 (43.18)	1.12 (0.59–2.14)	0.73	1.58 (0.72–3.50)	0.254
	40–65	25 (56.82)				

Table 4: Post-COVID conditions by sex and age (n=307). Bold p-values indicate statistical significance.

Post-COVID conditions were compared between young and middle-aged adults. Young adults were more likely to report every post-COVID condition, except changes in menstruation, which was reported to be higher among middle-aged adults (56.82%).

The occurrence of difficulty breathing (p = 0.015), tiredness and fatigue (p ≤0.001), post-exertion malaise (p ≤0.001), difficulty thinking and concentrating (p = 0.008), cough (p = 0.013), chest or stomach pain (p ≤0.001), headache (p ≤0.001), fever (p = 0.011), dizziness upon standing (p =

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0.013), and mood changes (p= <0.001) differed significantly between young and middle-aged adults. After adjusting for sex, the presence of prior health conditions, number of prior health conditions, number of past COVID infections, time of last COVID-19 diagnosis, vaccination status, the adjusted OR for cough and fever changed to insignificant (p = 0.125 and p = 0.299, respectively).

The presence of prior health conditions was not significantly associated with any of the post-COVID conditions. Perceived stress was significantly associated with all post-COVID conditions, except fever (p = 0.32) and rash (p = 0.46). Post-exertion malaise had the highest *Eta*-value (0.56, p ≤0.001) followed by difficulty thinking and concentrating (0.55, p ≤0.001) (Table 5).

Post-COVID Conditions	Likelihood Ratio	*df*	p-value	Eta-value
Difficulty Breathing	59.27	36	**<0.001**	0.48
Tiredness and Fatigue	102.98	36	**<0.001**	0.54
Post-Exertion Malaise	97.55	36	**<0.001**	0.56
Difficulty thinking and concentrating	98.73	36	**<0.001**	0.55
Cough	75.55	36	**<0.001**	0.51
Chest or stomach pain	48.3	36	**<0.001**	0.54
Headache	70.05	36	**<0.001**	0.45
Fast-beating or pounding heart	61.34	36	**0.005**	0.48
Joint and muscle pain	77.81	36	**<0.001**	0.46
Pins and needles sensation	58.24	36	**0.011**	0.42
Fever	39.44	36	0.32	0.42
Dizziness upon standing	57.56	36	**0.013**	0.46
Rash	36.64	36	0.46	0.38
Mood changes	95.48	36	**<0.001**	0.53
Changes in smell and taste	46.99	36	**0.002**	0.48
Changes in menstruation period	45.62	36	**0.024**	0.41

Table 5: Association between post-COVID conditions and perceived stress (n=307). Bold p-values indicate statistical significance.

Discussion

This study describes and compares the prevalence of post-COVID conditions among adults in Saudi Arabia. Age, sex, presence of prior health conditions, and perceived stress were evaluated as potential factors associated with post-COVID conditions. Post-COVID-19 conditions were found at least one month after COVID-19 diagnosis in approximately 75% of the participants. This result is in line with previous research showing that the prevalence of post-COVID conditions is substantial [16,17]. Given the high prevalence of post-COVID conditions among adults, an effective healthcare response is required for early detection and management. Required actions may include promoting access to high quality data to estimate the incidence of post-COVID conditions, characterize their presentation, and identify risk factors associated with post-COVID conditions [18].

Risk factors of post-COVID conditions have not been distinctly identified in the literature. Age, sex, prior health issues, and perceived stress level were all hypothesized to be associated with post-COVID conditions. However, this hypothesis was partially supported by the findings of the current study. The influence of age and sex on the epidemic characteristics of COVID-19 has been highlighted in previous research since the emergence of the disease, confirming that females are more susceptible to COVID-19 and that age is an important determinant of the incidence and severity of COVID-19 [19,20]. Similarly, the current study indicates that post-COVID conditions vary by age and sex. Specifically, females were more likely to report most post-COVID conditions than males. The occurrence of difficulty breathing (p <0.001), tiredness and fatigue (p = 0.007), fast-beating or pounding heart (p <0.001), and dizziness upon standing (p = 0.041) differed significantly between men and women. This result is similar to previous research revealing that female sex is associated with developing long-term post-COVID conditions [21]. Therefore, previous research has suggested the need for long-term follow-up from a sex-based perspective. Sex differences could be attributed to differences in immune function; however, understanding

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sex differences in post-COVID conditions requires further research to explore all possible factors.

Age, as a determining factor of post-COVID conditions, was found to be a significant factor among most patients. Participants were grouped by age to compare young adults and middle-aged adults; no older adults participated in this study. In contrast with previous research, the current study found that young adults were more likely to develop post-COVID conditions compared with middle-aged adults. Difficulty breathing (p = 0.015), tiredness and fatigue (p <0.001), post-exertion malaise (p <0.001), difficulty thinking and concentrating (p = 0.008), cough (p = 0.013), chest or stomach pain (p <0.001), headache (p <0.001), fever (p = 0.011), dizziness upon standing (p = 0.013), and mood changes (p <0.001) differed significantly between the two age groups.The CDC added that people who were not vaccinated against COVID-19 before the onset of the infection might be more vulnerable to developing post-COVID conditions than those who received the vaccine [2]. In Saudi Arabia, the COVID-19 vaccine was made available to all citizens and residents based on a phased strategic plan, starting with the most vulnerable populations, such as the elderly population and people with chronic diseases. In this study, more than two thirds of the participants (68.7%) acquired their last infection prior to completing their vaccination schedule, and middle-aged adults were more likely to have a completed vaccination status compared with younger adults. Therefore, vaccination status could be attributed to the difference in post-COVID conditions between young and middle-aged adults.

In addition to sex and age, this study assessed the association between prior health conditions, mainly chronic diseases, before the onset of the infection and post-COVID conditions. Although pre-existing comorbidities were associated with COVID-19 severity and mortality [22], they were not associated with post-COVID conditions in this study. This study found that almost 46% of participants with at least one prior health condition had complete vaccination status prior to the onset of the infection. Therefore, the findings of this study could be attributed to the impact of vaccines on COVID-19-related outcomes. In Saudi Arabia, people with comorbidities were prioritized by the ministry for vaccination. By August 2022, more than two thirds of the total population (70%) had already received at least the first dose of the vaccine [23]. Continued efforts to increase COVID-19 vaccination are needed to overcome post-COVID conditions and other COVID-19-related outcomes.

Perceived stress, another determinant of health, was examined as a risk factor of post-COVID conditions. To our knowledge, no previous study has examined perceived stress as a predictor of COVID-19 incidence, severity, or post-COVID conditions. Most studies have assessed perceived stress during the COVID-19 pandemic but did not assess associated factors. In the current study, the perceived stress level was found to be significantly associated with all post-COVID conditions, except fever and rash. People who reported higher levels of perceived stress were more likely to report one or more post-COVID condition. This finding is consistent with previous research indicating that chronic stress impacts physical and mental health [24].

The findings of this study should be considered in the context of the following limitations. First, reliance on snow ball sampling and self-reported data may limit the generalizability of the findings to all adults in Saudi Arabia and could bias participants' responses. While self-reported data is a quick and easy way to collect data, it is subjective to many factors, such as personal views, mood, and length of the questionnaire. In addition, delineating the temporal association between post-COVID conditions and stress could be difficult because the data were collected at the same time. This study is also limited by the lack of older adults (aged > 65 years). During the data collection phase, the inclusion criteria were aged 18 years or older, but unfortunately, we did not obtain any responses from older adults. This could be attributed to the fact that many older people in our community do not use smartphones or social media. To avoid these limitations in future research, cohort and case-control studies are recommended to investigate post-COVID conditions including participants from all age groups. Regardless of the above limitations, to our knowledge, this is the first study to investigate post-COVID conditions and associated risk factors in Saudi Arabia.

Conclusion

The current study raises awareness about post-COVID conditions in Saudi Arabia and the associated risk factors. We found that post-COVID conditions are prevalent in our community and vary by age, sex, and stress level. Our results suggest that sex differences and stress levels should be considered in health promotion programs for post-COVID conditions. In addition, the findings of this study suggest that more attention should be paid to young adults to reduce post-COVID conditions and improve their health outcomes. Public health systems must take action and develop initiatives to protect the public's health against post-COVID conditions. Development of health promotion programs and risk reduction initiatives from a sex perspective is needed to enhance health post-infection. Stress assessment and management strategies should be incorporated into such programs to achieve better outcomes. The identification of other factors that predict post-COVID conditions is needed to guide clinical care, improve health outcomes, and promote public health.

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